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(71) Applicant: MINER ENTERPRISES, INC. [US/US]; 1200 East State Street, Geneva, IL 60134 (US).

(72) Inventors: WYDRA, Neal, E.; 2 N 175 Berenice Avenue, Glen Ellyn, IL 60137 (US). RICHARDSON, Joel, C.; 934 Jennifer Drive, Batavia, IL 60510 (US). GEICK, David, W.; 506 Redwood Court, North Aurora, IL 60542 (US).

(74) Agent: ORUM, Keith, H.; Dvorak and Traub, 53 West Jackson Boulevard, Chicago, IL 60604 (US).

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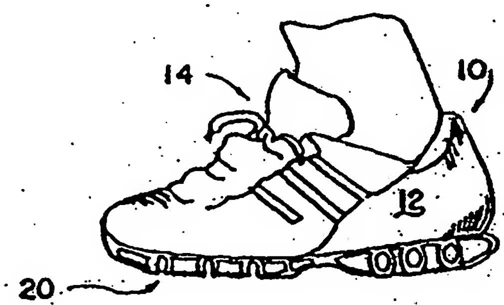
(54) Title: ELASTOMER MIDSOLE SHOE STRUCTURE

(57) Abstract

A midsole (20) for an athletic shoe having a first generally flat layer (32) and a second generally flat layer (36) separated by cylindrical springs (34) formed of an elastomer having a ratio of plastic strain that is greater than 1.5 to 1, the molecular structure of the midsole being oriented as a result of compression of the material.



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ELASTOMER MIDSOLE SHOE STRUCTURE

BACKGROUND OF INVENTION

Field of Invention. This invention primarily relates to a midsole of an athletic shoe, particularly a running shoe. More specifically, it is directed to a lightweight molded, foamless, shock absorbing mid-sole that will adequately absorb a runner's impact forces and simultaneously provide durability, longitudinal stability and lateral support.

Related Art. For years, the athletic shoe industry has continually sought to improve athletic shoes. In large part, the focus has been upon comfort and absorption of the impact forces caused by the runner's heel striking the ground. Each prior art shoe and patent seem to focus upon the improvement of one or two important characteristics of the shoe design. For example, Cohen, Patent No. 4,754,559 appears to focus upon energy absorption and is primarily directed to the placement of "ribs" in the mid-sole or, alternatively, the insertion of tubes into the midsole. Cohen recommends the use of a "rubber like" material. Another patent, Derderian, *et.al.*, No. 4,535,553 focuses upon shock absorption and is directed to a midsole combination of an elastomeric foam and resilient insert member formed of Hytrel 4056.

SUMMARY OF INVENTION

Our invention is a midsole for an athletic shoe. More particularly, it is a molded midsole formed of an elastomer whose ratio of plastic deformation to elastic deformation is greater than 1.5 to 1. Preferably, the elastomer is a copolyester polymer elastomer such as that manufactured and sold by E.I. duPont de Nemoirs under the trademark Hytrel.®

In the preferred embodiment, the midsole takes the shape of a flexible upper layer separated from a lower, ground engaging layer by cylindrical shaped springs that are integrally joined to the upper and lower layers. This midsole has a rear-foot section in which the springs are in

the shape of a plurality of truncated right cylindrical springs that extend from outside the lateral and medial sides of the shoe to a position underneath the shoe. Preferably, these individual cylindrical springs are not continuous, but are interrupted underneath the rear-foot section, and in conjunction with the lower layer, define a circumferential support surface that extends around the rear-foot section. The midsole of our invention also includes mid-foot section as well as a fore-foot section. As will be shown, the cylindrical springs incorporated into rear-foot and the fore-foot sections are unique and fully provide the desired energy absorption, longitudinal and lateral support.

Accordingly, the objectives of this invention are to provide, *inter alia,*

1) a unique elastomeric compression midsole that will substantially reduce the weight of the traditional running shoe while maintaining, if not enhancing, the ability of the shoe to absorb the impact energy of the runner without transmitting it to his joints;

2) an elastomeric midsole unit that will provide substantial longitudinal stability as well as exceptional lateral support;

3) an elastomer midsole that will provide vertical softness and effectively cushion the runner's impact with the ground while simultaneously providing lateral stiffness;

4) an energy absorbing midsole that will not loose its resiliency over time;

5) a midsole whose resiliency and energy absorbing ability is not affected by moisture and perspiration;

6) an elastomer compression midsole that is most durable and not subject to tear propagation;

7) a midsole that will substitute stability and support for the mushy feeling left by some of the foam, air or fluid systems; and

8) a lightweight spring unit for simultaneously absorbing impact energy and for flexing in response to

angular movements.

DESCRIPTION OF THE DRAWINGS

The manner in which these objectives and other desirable characteristics can be obtained from this invention is explained in the following specification and attached drawings in which:

Figure 1 is a perspective view of a running shoe;

Figure 2 is a plan view of the preferred embodiment of the midsole of this invention;

Figure 3 is a sectional side elevation view of the preferred embodiment of the invention, the view taken along the lines 3-3 of figure 2;

Figure 4 is a perspective view of the preferred embodiment of the bottom of midsole of this invention;

Figure 5 is an elevational view taken along the lines 5-5 of figure 8;

Figure 6 is another side elevation view of a preferred embodiment depicting the invention in the flexed position;

Figure 7 is a side elevational view of the rear-foot section of a "preform" of our invention; and

Figure 8 is a side elevational view of the rear-foot section of the invention after it has been compressed to eliminate compression set of the plastic material.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The preferred embodiment of our invention is illustrated in one intended environment in Figure 1. Such includes a running shoe 10 with an upper 12 that completely covers the foot and has the usual eyelets and lacing 14 on the top with a multilayered sole 20.

In this case, the multilayered sole 20 comprises the preferred embodiment of the midsole invention. As shown in figure 3, this midsole is divided into three sections along its longitudinal axis. These sections include a rear-foot section 24, a mid-foot section 26 and a fore-foot section 28. These sections and the entire midsole are molded as one integral piece. Preferably, they are injection molded with

an elastomer having tensile characteristics such that the ratio of plastic strain to elastic strain is greater than 1.5 to 1. One such elastomer is a copolyester polymer elastomer manufactured and sold by E.I. du Pont de Nemoirs under the trademark Hytrel.® It is reasonably inert and significantly, it is quite durable. Moreover, this elastomer is not subject to tear propagation even when made in relatively thin cross sections. We prefer to use du Pont's Hytrel® composition no. 5556. (For a more complete description of this elastomer, see U.S. Patent No. 4,198,037 and the references cited therein).

From top to bottom, the midsole 20 of this invention includes a generally flat top ply or layer 32 of elastomeric material from which depends generally cylindrical springs 34 that are integrally joined to a flat ply or bottom layer 36 as shown in figures 3 and 4. The top layer 32 is also directly joined to the bottom layer 36 at the front 33 of the midsole 26, at the mid-foot section 26 and at the rear 35 of the midsole as shown in figure 3.

In the rear-foot section, the cylindrical springs 34 are preferably truncated, right cylinder sections. These springs 34 need not and do not extend completely across the rear-foot section 24. Instead, these springs 34 are positioned in a generally U-shaped configuration about the circumference of the rear-foot section, leaving a void or recess 40 in the center of the rear-foot. The void and the resulting elimination of material provides substantial weight reduction. Significantly, the recess 40 and the weight reduction is permitted by the selected material and the manufacturing process described herein.

The illustrated interconnections of the upper layer 32 and the lower layer 36 provide excellent longitudinal stability. In addition, the outward extensions 35 of the cylindrical springs 34 beyond the circumference of the upper 12 provides a wider platform for the runner's foot. Significantly, these design of these extensions 35, their length and the direction of the cylinder sections 34 is used,

in part, to control the "roll" of the runner's foot. In addition and as reflected in figure 4, the wall thickness of the cylindrical springs 34 of the rear-foot section is thicker on the medial side of the shoe than on the lateral side. This increased thickness is also used to provide the desired control of the motion of the foot.

The extension of the recess or void section 40 from the rear-foot section into the fore-foot section also provides torsional flexibility to the midsole and to the shoe. The forward extension of this recess is permitted since the strength of the material around the circumference of the shoe is more than adequate.

Support for the fore-foot section of the midsole is also provided by cylindrical springs as shown in figures 3,4 and 6. These springs 42 have a construction that is slightly different from the cylindrical springs 34 of the rear-foot section. One difference is that the springs 42 extend across the entire width of the midsole. In addition, they are slightly tapered from the medial to the lateral side of the shoe, *i.e.*, the cross sectional thickness of the cylinder walls is greater on the medial side. In addition and to provide added flexibility, the cylinder springs of the fore-foot section are slit as at 44. As best illustrated in figure 6, this slit along the bottom surface of the cylinder spring and the midsole provides substantial, added flexibility to the fore-foot. Indeed, as the foot rolls farther forward, the cylinder sections 34 are permitted to open and enhance the flexibility of the shoe.

In the manufacture of the invention, the midsole 20 is preferably injection molded. However, it is well known that the Hytrel® material will take a compression set. For this reason, our invention is molded into a preform, and is subsequently compressed to take that set. As is taught in U.S. Patent Application, Serial No. 07/823,930 entitled Radial Elastomer Compression Spring, now U.S. Patent No. 5,280,890, compression of the Hytrel® material not only causes the material to take a set, the compression also

results in orientation of the molecular structure and enhances the spring characteristics of the material. The information of that patent is incorporated herein by reference.

The effect of this compression is illustrated in Figures 7 and 8. Figure 7 illustrates this taller preform that has been molded but not compressed. After the preform has been removed from the mold and allowed to coil and stabilize for up to twenty-four hours, it is then compressed, preferably to a solid position. Upon release of the compressive force, the upper and lower layers 32 and 36 will partially spring back, leaving the cylindrical springs 34 in an oval configuration as shown in figure 8. The midsole takes a "set" in this position. Thereafter, these springs 34 may be partially compressed during use by the runner, but as his weight is removed, the springs will return to the "set" oval position shown in figure 8.

In as much as individuals vary in weight and size, there is no one manufacturing design for our invention that will accommodate all individuals. Consequently, some experimentation for each potential application will be required. Nevertheless, a primary, desirable design procedure to obtain the desired cylindrical wall thicknesses is to make two or more units with different dimensions, correlate their dimensions to their resulting spring rate and then interpolate or modify the dimensions until the desired spring rate is obtained.

Persons skilled in the art of plastic forming and compression spring design will discover that many modifications of our invention will also produce satisfactory results. Elastomers other than Hytrel® may be acceptable for some applications. Similarly, the dimensions of the cylinders and their wall taper as well as thickness may vary from design to design. In addition, the process of molding the compression spring of our invention can also include various modifications. As noted in figures 2 and 3, a lip 22 that conforms to the outer surface of the upper may be added

around the circumference of the midsole. In addition, the top ply 32 of the midsole may extend completely across the recess to eliminate any void in the heel support. In addition, an abrasive resistant surface may be added to the lower surface 36 of the midsole. Finally, the recess 40 may extend throughout a major portion of the fore-foot. These and other variations, which will be appreciated by those skilled in the art, are within the intended scope of our invention as claimed below.

We claim:

1. A foamless, lightweight midsole structure for an athletic shoe, said structure comprising;

a) a midsole structure having a first, generally flat layer adapted to be mounted to an athletic shoe, generally cylindrical sections extending horizontally across the midsole and descending downwardly from said first flat layer to a second, generally flat surface layer for engagement with the ground surface;

b) said midsole structure being formed of an elastomer having a ratio of plastic strain to elastic strain that is greater that 1.5 to 1, the molecular structure of said member being oriented as a result of plastic deformation of said web sections in at least one direction;

c) said cylindrical sections together with said first and second layers defining

1) a rear-foot section;

2) a mid-foot section that, relative to the rear-foot section, is relatively thin in cross section;

3) a fore-foot section that terminates in an apex near the front of the midsole structure; and

d) said cylindrical sections and said second layer being abridged to define a circumferential, U-shaped support and resilient impact section with a recessed center section, said U-shaped support section extending around the circumference of the heel of the shoe and forward to fore front.

2. A midsole structure for an athletic shoe as recited in claim 1 in which said cylindrical sections of said fore-foot extend generally perpendicular to the longitudinal axis of the midsole structure and include a slit adjacent the second, surface layer to enhance the flexibility of the midsole.

3. A midsole structure for an athletic shoe as

recited in claim 1 in which said cylindrical sections of the rear-foot section take the shape of truncated right cylinders and extend beyond the circumference of the shoe upper.

4. A midsole structure for an athletic shoe as recited in claim 1 in which said cylindrical sections of said fore-foot are tapered from the medial to the lateral sides of the shoe.

5. A foamless, lightweight midsole structure for an athletic shoe, said structure comprising;

a) an elongated midsole structure having a first generally flat layer adapted to be mounted to an athletic shoe, said layer having generally cylindrical sections descending downward from said first layer;

b) said cylindrical sections having a major axis perpendicular to the longitudinal axis of said elongated midsole structure;

c) a second generally flat layer integrally joined to said cylindrical section;

d) said midsole structure and said cylindrical sections being formed of an elastomer having a ratio of plastic strain to elastic strain that is greater than 1.5 to 1, the molecular structure said member being oriented as a result of plastic deformation of said cylindrical sections in at least one direction;

e) an elongated recess defined by interruptions in the cylindrical sections, said recess extending longitudinally of the midsole for a major portion of its length; and

f) at least some of the cylindrical sections and said second layer being slit in a direction parallel to the major axis of said sections to enhance the flexibility of said midsole.

6. An improved midsole as recited in claim 5 in which said recess is formed by cutouts of said cylindrical sections and of said second layer.

7. An improved midsole as recited in claim 5 in which said cylindrical sections define a U-shaped support and a resilient impact section extending around the circumference of the rear of the midsole and extends forward.

8. An improved midsole as recited in claim 5 in which the thickness of the cylindrical sections are thicker on one side of the midsole.

9. A spring unit for simultaneously absorbing impact energy and for flexing in response to angular movements, said spring unit comprising;

a) a flexible elongated first layer;

b) at least one elongated cylindrical unit integrally joined to said first layer and descending downwardly, said cylindrical unit having a major axis that is generally perpendicular to the major axis of said elongated layer and is capable of absorbing energy;

c) a second flexible elongated layer integrally joined to said cylindrical unit, said cylindrical unit and said second layer being split to permit said cylindrical unit to open up and provide greater flexibility to said unit; and

d) said spring unit being formed of an elastomer material having a ratio of plastic strain to elastic strain that is greater than 1.5 to 1, the molecular structure of the cylinder being oriented in at least one direction.

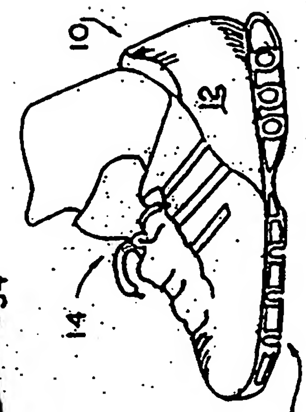

FIG-1

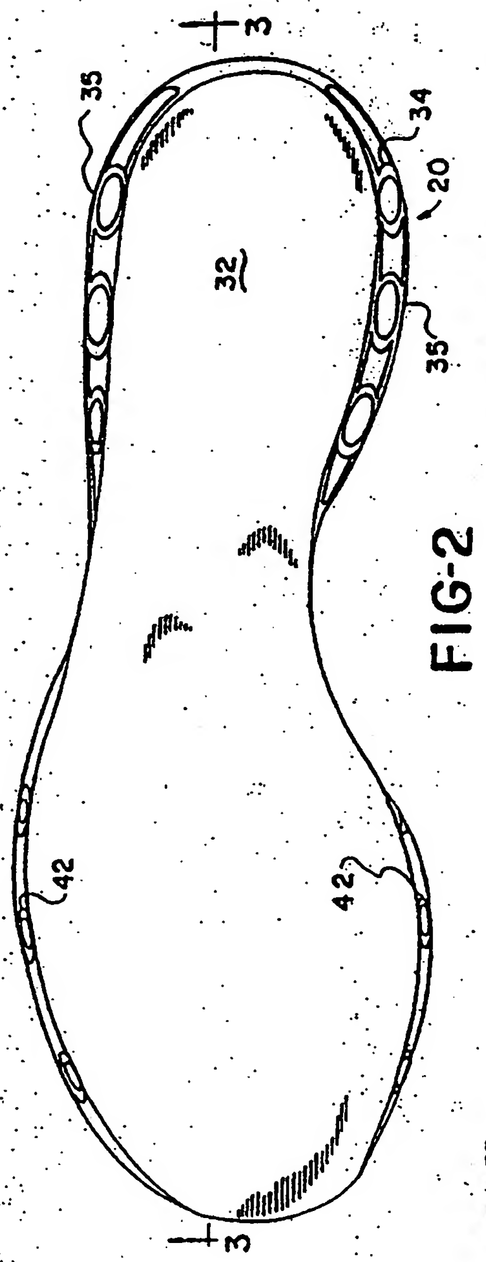

FIG-2

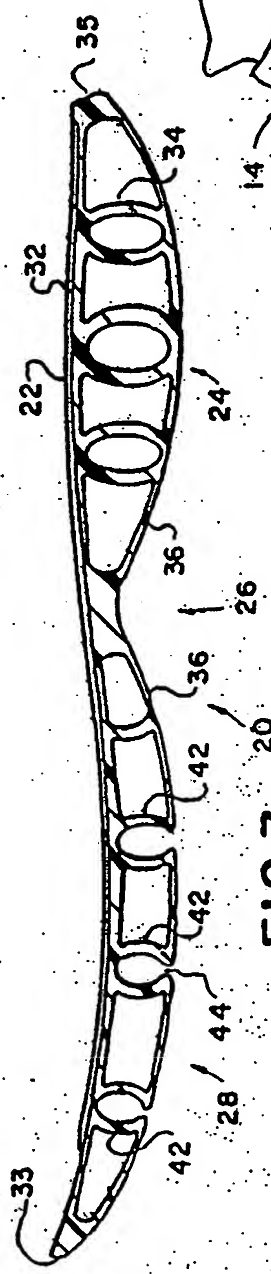

FIG-3

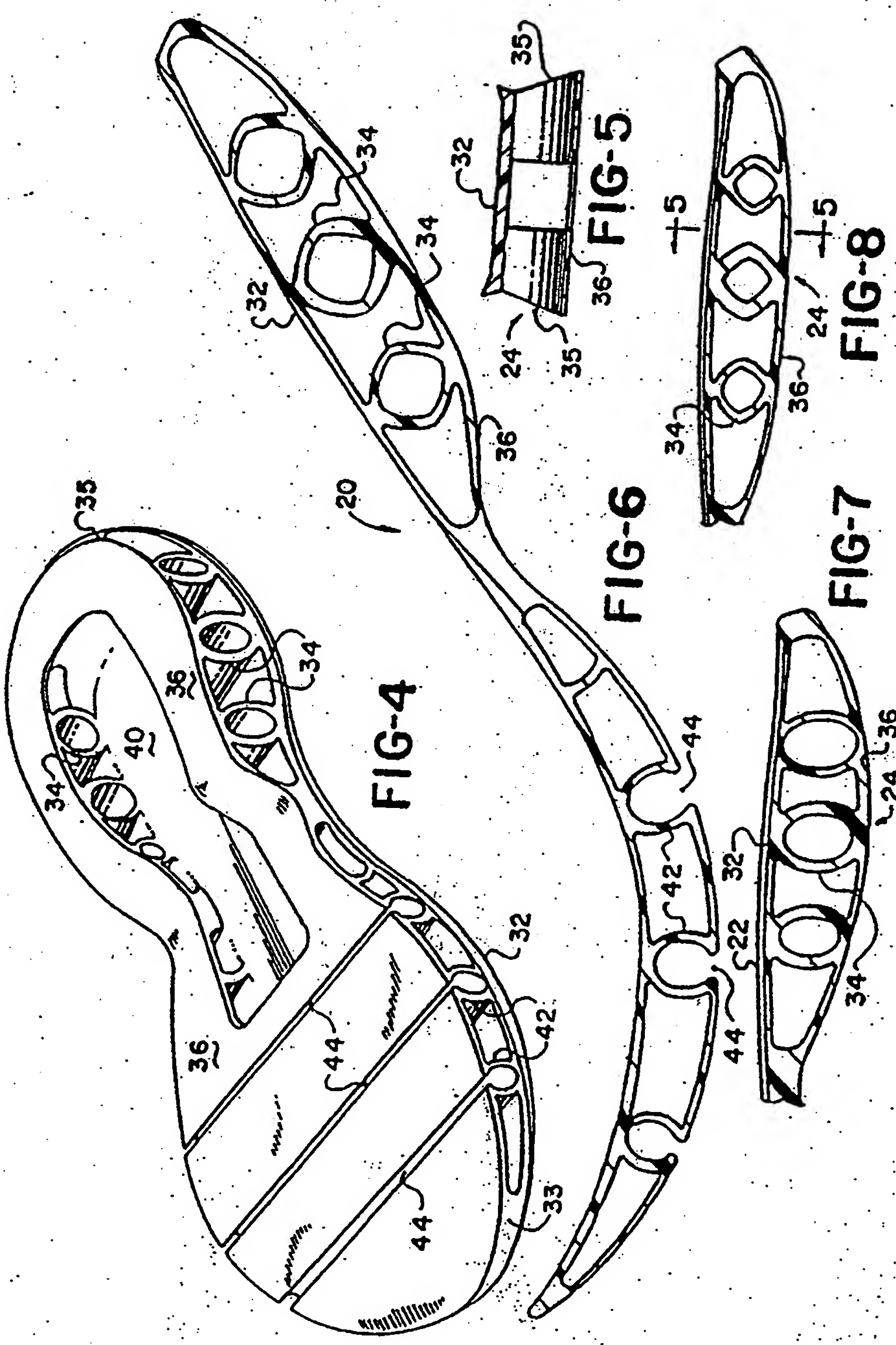
FIG-4
FIG-5
FIG-6
FIG-7
FIG-8
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/00334

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :A43B 13/18; A43B 13/12
US CL :036/030.00R, 028.000
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 036/030.00R, 028.000, 027.000, 032.00R, 037.000

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 4,536,974 (COHEN) 27 August 1985, See the entire document.	1-9
Y	US, A, 5,280,890 (WYDRA) 25 January 1994, See the entire document.	1-9
Y	US, A, 5,280,680 (BURKE) 25 January 1994, See the entire document.	1-8
Y	US, A, 3,024,790 (MCCARTHY) 13 March 1962, See the entire document.	1-4
Y	US, A, 4,546,556 (STUBBLEFIELD) 15 October 1985, See the entire document.	3
Y	US, A, 4,578,882 (TALARICO, II) 01 April 1986, See the entire document.	4, 8

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/00334

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US, A, 4,198,037 (ANDERSON) 15 April 1980	1-9
A	US, A, 5,005,299 (WHATLEY) 09 April 1991	1-8